Project Report: Identification and Study of Hydrothermal Systems on Mars Through Remote Sensing

Lead Team:	***University of Colorado, Boulder***
Project Title:	***Identification and Study of Hydrothermal Systems on Mars Through Remote Sensing***

Project Progress

Life on early Earth seems to have appeared in hydrothermal environments, where liquid water, biogenic elements and a source of energy were available. Minerals characteristic of hydrothermal systems (both fossil and active) can be identified through their infrared emissivity spectra by instruments such as the Thermal Emission Spectrometer (TES), onboard the Mars Global Surveyor. Another characteristic of hydrothermal environments is the presence of a wide variety of mineral species, which translates into a large amount of spectral variability.

Software is being developed to access, process and analyze TES emissivity data in order to detect hydrothermal systems on Mars. Analyzing all the information present in the TES data is a challenging task, due both to extensive geographic coverage and to numerous spectral bands. In order to determine what areas of Mars are more "spectrally interesting" (because of their larger spectral variability), a Variance Index has been devised. Daytime TES emissivity spectra have been gathered for 5−by−5 degree cells covering the entire planet. The data have been selected according to several quality criteria (acquisition geometry, atmospheric conditions, and instrument performance). The spectral noise has been estimated using black body emissivity data acquired onboard, and then segregated from the TES data applying a principal components−like transformation. The amount of spectral variance present in the noise−corrected emissivity data has been computed, and a global Variance Index map of Mars has been generated. Regions with high Variance Index are then individually analyzed. Linear mixing−based models are applied to identify the purest (most spectrally extreme) spectra that can explain all the spectral variability present in each of these regions. These data−derived endmembers are then compared to spectral libraries for their identification.

Mars Odyssey Themis data will allow a complementary analysis of areas selected from the Variance Index map, because of its improved spatial resolution. Preliminary analysis of Themis data is in progress.

Highlights

- A Variance Index has been devised. This index allows the quantification of the amount of spectral information present in the TES emissivity spectra.
- A 5−by−5−degree Mars global Variance Index map showing regions of higher spectral variability has been generated.

Roadmap Objectives

- ***Objective No. 8:*** Past Present Life on Mars

Mission Involvement

*Mission Class**	*Mission Name (for class 1 or 2) OR Concept (for class 3)*	*Type of Involvement***
1	Mars Global Surveyor	Data analysis
1	Mars Odyssey	Data analysis

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long−lead future mission / societal issues (e.g., far−future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co−I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

In this project I am analyzing radiance data acquired by the Mars Global Surveyor Thermal Emission Spectrometer and the Mars Odyssey Themis instruments.

Cross Team Collaborations

This project has benefited from help provided by members of the NAI Arizona State University team. Phil Christensen organized and chaired a very informative TES workshop as well as scientific meetings for both the TES and Themis instruments. Steve Ruff, Josh Bandfield, Noel Gorelick, and Kim Murray were of great help answering questions on TES and Themis data organization. Mike Smith made his atmospheric correction model available for this project.